

## Chiton Fauna of the Galápagos Islands

BY

'ALLYN G. SMITH AND ANTONIO J. FERREIRA<sup>1</sup>

(4 Plates)

### FOREWORD

ON HIS DEATH, AUGUST 18, 1976, Allyn Goodwin Smith left a nearly completed manuscript on the chiton fauna of the Galápagos Islands with the expressed request that I would complete his work and see it published. In humble spirit I strove to carry out his wish. Although in the process alterations were made upon the original manuscript, most of such alterations merely reflect the consensus we had reached in the course of discussions over the contents of the paper. Thus, Allyn's work on the Galápagos chitons is preserved virtually unchanged. The credit is Allyn's, the responsibility mine.

A. J. F.

### INTRODUCTION

THE FIRST COLLECTIONS of Galápagos chitons for scientific purposes were made early in the nineteenth century. The large endemic species, *Chiton sulcatus*, was described in 1815 by Wood and *C. goodalli* by Broderip in 1832, the latter obtained by the famous British collector and conchologist, Hugh Cuming, who probably found *Acanthochitona hirudiniformis* there also. Other species now known to make up the Galápagos chiton fauna are not often collected, or are small and easily overlooked.

The purpose of this report is to assemble such information on Galápagos chitons as has appeared in the literature, supported by specimens in the collection of the California Academy of Sciences and in other institutions, and by personal observations. The principal sources of records and specimens have been the major scientific expeditions

to the Islands, the earlier ones having been summarized by STEARNS (1893). Since that date collections have been made during the Hopkins-Stanford Expedition in 1898-1899, the California Academy of Sciences Expedition in 1905-1906, the Cambridge Expedition to the Suez Canal in 1924, the Norwegian Zoological Expedition in 1925, the Gifford Pinchot Expedition in 1929, the G. Allan Hancock Expedition of the California Academy of Sciences in 1931-1932, the California Academy of Sciences Expedition under the auspices of Templeton Crocker in 1932, the William K. Vanderbilt South Pacific Expedition in 1933, the George Vanderbilt South Pacific Expedition in 1937, the United States Presidential Cruise in 1938, and the Galápagos International Scientific Project in 1964.

As one of the privileged participants in the Galápagos International Scientific Project (GISP), the senior author (AGS) had the opportunity to collect chitons as well as land and other marine invertebrates and to make field observations during the period January-March, 1964, while this Expedition was headquartered at the Charles Darwin Research Station on Academy Bay, Isla Santa Cruz. Most collections of chitons were made in the intertidal zone supplemented by a limited amount of dredging in 30m or less. Personal collecting was assisted and augmented by several other GISP scientists and by two enthusiastic local conchologists living in Academy Bay Village — Mrs. Fritz (Carmen) Angermeyer and Mme. André (Jacqueline) De Roy — to whom special thanks are due.

The archipelago of the Galápagos (Archipiélago de Colón) consists of 12 large and several hundred small islands on the equator, some 1000km west of Ecuador, to which country they belong. Potassium-Argon dating of the geologically oldest flows exposed indicate that the Galápagos Islands have a probable maximum age of 3 000 000 years (BAILEY, 1976).

<sup>1</sup> Mailing address: 2060 Clarmar Way, San Jose, California 95128

Table 1

Family, Genus, and Species	Habitat
LEPIDOPLEURIDAE	
<i>Leptochiton albermarlensis</i> A. G. Smith & Ferreira, spec. nov.	Dredged, 20 m; endemic?
ISCHNOCHITONIDAE	
<i>Ischnochiton petaloides</i> (Gould, 1846)	Intertidal zone to 100 m
CHAETOPLEURIDAE	
<i>Chaetopleura</i> cf. <i>C. mixta</i> (Dall, 1919)	Intertidal zone
<i>Calloplax duncanus</i> (Dall, 1919)	Intertidal zone
CALLISTOPLACIDAE	
<i>Callistochiton carmenae</i> A. G. Smith & Ferreira, spec. nov.	Intertidal zone; endemic?
CHITONIDAE	
<i>Chiton goodalli</i> Broderip, 1832	Intertidal zone; endemic
<i>Chiton sulcatus</i> Wood, 1815	Intertidal zone; endemic
<i>Toncia forbesii arnheimi</i> Dall, 1903	Intertidal zone to 50 m; endemic
ACANTHOCHITONIDAE	
<i>Acanthochitona hirudiniformis</i> (Sowerby, 1832)	Intertidal zone
<i>Acanthochitona jacquelinae</i> A. G. Smith & Ferreira, spec. nov.	Dredged, to 50 m; endemic
<i>Acanthochitona</i> cf. <i>A. avicula</i> (Carpenter, 1866)	Intertidal zone

The chiton fauna of the Galápagos Islands is not large; nor is it particularly notable except for the occurrence of 2 large, spectacular species of *Chiton*, *C. sulcatus* and *C. goodalli*. Other Galápagos chiton species are considerably smaller when adult, and are not especially abundant. Table 1 lists the species making up the Galápagos chiton fauna; to-date, it includes only 11 species in 8 genera, representing 6 families. It seems worth noting that possibly as many as 7 of the total 11 species, or 64%, are endemic to the Galápagos Islands although it is probable that this percentage will be somewhat reduced with more thorough collecting. In spite of the apparent high degree of endemism, however, the Galápagos chiton fauna is essentially Panamic in composition. The influence of the cold, northward flowing Humboldt Current, which impinges on the Galápagos Islands, does not seem to have affected the chitons inasmuch as no species commonly occurring on the coasts of Perú and Chile are found.

### SYSTEMATIC TREATMENT

The following account lists the known species of chitons inhabiting the Galápagos Islands, describes 3 considered to be new to science, brings together all published records, and includes comments that may be helpful in adding to the knowledge of each species. The list includes 7 species that have been reported from the Islands, which reflect either erroneous records, misidentifications, or species of

such rare occurrence that they cannot be accorded permanent status in the chiton fauna of the archipelago.

### POLYPLACOPHORA de Blainville, 1816

#### NEOLORICATA Bergenhayn, 1955

##### LEPIDOPLEURIDAE Pilsbry, 1892

Only one representative of this family has been collected in near shore waters. In addition, one species occurs in very deep water off-shore, although further dredging is likely to produce others.

##### *Leptochiton* Gray, 1847

##### *Leptochiton albermarlensis* A. G. Smith & Ferreira, spec. nov.

(Figures 1, 2)

**Diagnosis:** Animal of moderate size, round-backed and cream colored. Over-all decoration of closely spaced, fine granulations on the dorsal side of the valves. Girdle narrow and spiculate.



**Description of the Holotype:** Holotype a whole animal, preserved dry, the valves all somewhat broken but showing the characters of the species satisfactorily. Color of both valves and girdle a light cream. Valves round-backed, the head valve rounded and somewhat more than semicircular; the intermediate valves have straight, unmucronate posterior margins; the lateral areas hardly raised and set off from the central areas; the tail valve semicircular with a prominent, rounded, centrally-placed mucro. Dorsal sculpture consists of a series of very fine, slightly elongated, unconnected granulations arranged in close diagonal rows. There are 2-3 shallow grooves close to the side margins of the valves and parallel to them, which are somewhat better developed on valves ii and vii. The girdle has short, closely set, somewhat appressed, slightly curved or straight, glass-like, blunt-pointed spicules. Dimension are: length, 9.8mm; width, 5.4 mm; height, 1.5mm. The holotype is deposited in the California Academy of Sciences Geology Department (C ASG) Type Collection, no. 58247.

**Type Locality:** Dredged in 20m, Tagus Cove, Isla Isabela (Albemarle Island), Galápagos Islands, 27 January 1968 by André and Jacqueline De Roy. A second disarticulated specimen with all valves badly broken was dredged with the holotype. It is here designated as a paratype (CASG Type Collection no. 58248).

**Remarks:** This new *Leptochiton* compares most closely in general size and shape with *L. rugatus* (Pilsbry, 1892) from central and southern California and from the Gulf of California. However, the latter species has the granular sculpture of the central areas on the intermediate valves arranged in connected, longitudinal rows, and the girdle is decorated with tiny sand-like granules with no spicules. Because of its spiculate girdle, *L. albemarlensis* may be related to *L. nexus* Carpenter, 1864, from moderately deep water, 37-146m, off Catalina Island, California, which has some girdle spicules along with narrow, striated scales. However, we are not sufficiently acquainted with

the detailed characters of *L. nexus*, a poorly known southern California species, to do more than suggest that a possible relationship may exist.

*Leptochiton opacus* (Dall, 1908)

(Figures 3, 4)

*Lepidopleurus opacus* DALL, 1908: 354-355

This rare and little-known chiton was dredged by the USS *Albatross* of the United States Fish Commission between the Galápagos Islands and the Peruvian coast in 2005 fathoms (3670m), ooze, bottom temperature 35.4° F (approx. 2°C) (USFC Sta. 4647). It is illustrated here for the first time. The type lot consists of 2 specimens, preserved dry, that appear to be adults, deposited in the U.S. National Museum of Natural History (USNM 110664). One, considered to be the holotype, is represented by only 7 disarticulated valves, the valve vii being missing. Because of its deep bathyal habitat, *L. opacus* cannot be included properly in the chiton fauna of the Islands, and it is noticed here only because its locality is in the general vicinity.

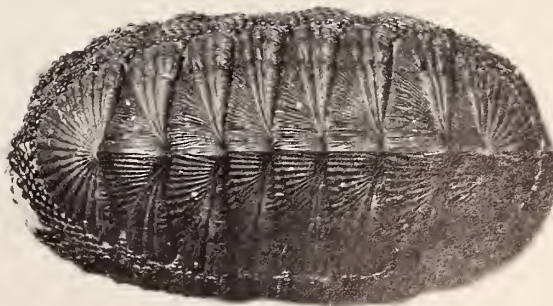
ISCHNOCHITONIDAE Dall, 1889

Ischnochitonids are uncommon in the Galápagos Islands. The species most often collected is quite small. Lacking are the larger Panamic species in the genus *Stenoplax* that occur in the Gulf of California and southward, such as *S. limaciformis* (Sowerby, 1832) and *S. magdalenensis* (Hinds, 1843), and in the genus *Lepidozona*, such as *L. clathrata* (Reeve, 1847). The genus *Lepidozona* does not seem to be represented in the Galápagos fauna; specimens previously alluded to as possibly belonging to the genus (FERREIRA, 1974: 175) prove to be, on closer investigation, representatives of the genus *Callistochiton*.

Explanation of Figures 1, 2, 5, 13, 14

Figure 1: *Leptochiton albemarlensis* A. G. Smith & Ferreira, spec. nov. Holotype (CASG Type Collection, No. 58247). Albemarle Island (Isla Isabela), dredged in 20m, Tagus Cove. Dorsal view; length, 9.8mm (AJF photograph)  
 Figure 2: *Leptochiton albemarlensis* A. G. Smith & Ferreira, spec. nov. Same as in Figure 1. Close-up of left side-slope to show detail of sculpture of valves and girdle. (AJF photograph)  
 Figure 5: *Ischnochiton (Rhodoplax) petaloides* (Gould, 1846). Lot

#3 (CASG 40497). Academy Bay, Isla Santa Cruz, intertidally. Largest specimen, 8.7mm long (AJF photograph)  
 Figure 13: *Chiton goodallii* Broderip, 1832. Academy Bay, Isla Santa Cruz. Dorsal view; length, 104.5mm (CASG 39264). From CASIZ Color Slide No. 1367 (AGS photograph)  
 Figure 14: *Chiton sulcatus* Wood, 1815. Conway Bay, Isla Santa Cruz. Crocker Galápagos Expedition, 1932, coll. Leo G. Hertlein (CASIZ Collection). From CASIZ Color Slide No. 1369 (AGS phot.)







*Ischnochiton* Gray, 1847*Ischnochiton (Rhodoplax) petaloides* (Gould, 1846)

(Figure 5)

*Chiton petaloides* GOULD, 1846: 6*Radiella petaloides*. THORPE (in KEEN), 1971: 869, no. & fig. 19*Ischnochiton mariposa* DALL, 1919: 506-507

In the Galápagos Islands, this small chiton is known to attain an adult length of about 11 mm. It is found sparsely in the intertidal zone, on the underside of rocks, to a depth of at least 100 m. Specimens may be unicolored, or mottled and striped in various light to dark combinations of color; some may have the characteristic electric-blue small spots, but zebra-striped color forms have not yet turned up among the specimens of *Ischnochiton petaloides* collected in the Galápagos Islands.

*Ischnochiton petaloides* has a unique range (A. G. SMITH, 1977). It is known from Hawaii, type locality (Maili, Oahu Id., Hawaiian Islands, leg. Kay Gudnason, low intertidal zone, 1974, CASIZ Colln.; lagoon opposite Hawaii Kai, Oahu, and E of Wailupe, Oahu, leg. H. Bertsch, Dec. 1976-Jan. 1977, AJF Colln.), the outer coast of Baja California from Punta Abreojos (26°42'N; 113°34.5'W, in 8-10 m, leg. J. H. McLean, R/V *Searcher* sta. 1, January 27, 1971, LACM 71-3) southwards to Cabo San Lucas, and throughout the Gulf of California. It is present, although rarely collected in Central America (El Velero, Nicaragua, intertidally, leg. A. J. Ferreira, January 21-22, 1974, AJF 132-133; Bahía Herradura, Puntarenas Province, Costa Rica, 10-20 m, leg. J. H. McLean, R/V *Searcher* sta. 447, March 9-10, 1972, LA CM 75-52; Tonasi, Las Santar, Bucaru Playa, Panamá, leg. E. Bergeron, April 23, 1967, LACM B-23), and in the northern part of South America (El Rubio & Punta Mero, Tumbes Province, Perú, intertidally, leg. J. H. McLean, D. Shasky, and Peña, April 16, 1972, LACM 72-85; Lobos de Afuera Islands, Perú, January 17, 1935, LACM-AHF 391-35; Salinas, Ecuador, 2°12'S; 80°58'W, intertidally, leg. J. H. McLean, 5-6 March, 1970, LACM 70-9). In the Galápagos Islands, 14 lots of *I. petaloides* were collected by A. G. Smith and others at Isla Santa Cruz, Isla Genovesa, Isla Isabela, Isla San Cristobál, Isla San Salvador, and Isla Rábida. During the California Academy 1932 Expedition, *I. petaloides* was collected at Conway Bay, N side of Isla Santa Cruz, by Leo G. Hertlein (CASG 27232). *Ischnochiton petaloides* is the only chiton so far known that is common to both the Indo-

West Pacific (Hawaiian Islands), and the tropical West American provinces; this observation is all the more noteworthy when only a few other mollusks, all gastropods, have been reported to span the faunistic barrier between the two zoogeographic zones (ROBERTSON, 1975).

Except for the relatively smaller size of the specimens examined, and somewhat less variability in colors, *Ischnochiton petaloides* from the Galápagos Islands does not seem to differ from other populations of the same species in the Gulf of California, Central America and Hawaii.

**Remarks:** The synonymy of *Ischnochiton mariposa* Dall, 1919 was established through the examination and side-by-side comparison of the syntype series of *I. mariposa* (USNM 58865) and the holotype of *Chiton petaloides* Gould, 1846 (USNM 12922) available on loan through the kindness of Dr. Joseph Rosewater. Within the genus *Ischnochiton* the systematic position of the species is, together with *I. eucosmius* Dall, 1919, in the subgenus *Rhodoplax* Thiele, 1893 (Type species, *Chiton squamulosus* C. B. Adams, 1845 [= *I. striolatus* (Gray, 1828)] by SD, herein) established to include relatively small, weakly-sculptured species with striated girdle scales and a tricuspid major lateral radular tooth.

It should be noted that THORPE in KEEN (1971: 869) had already placed *Ischnochiton mariposa* in the synonymy of *I. petaloides*, but with a generic change to *Radiella* Pilsbry (including *Rhodoplax* Thiele, 1893), which cannot be justified inasmuch as *Radiella* Pilsbry (type species *Ischnochiton tridentatus* Pilsbry, 1893, by OD) was clearly erected to include "... Ischnochitons (with) insertion-plates of the intermediate valves having two or several slits." (PILSBRY, op. cit. 14: 140), while Thorpe, following THIELE (1929) used the name to signify "American species" which, without supporting evidence, he considered distinct from "Old World species" of *Ischnochiton*.

## CHAETOPLEURIDAE Plate, 1899

*Chaetopleura* Shuttleworth, 1853*Chaetopleura* cf. *C. mixta* (Dall, 1919)

(Figures 6, 7)

*Tonicia mixta* DALL, 1919: 515

The 11 specimens of this small *Chaetopleura*, referred provisionally to *C. mixta*, were collected in the low intertidal zone, under rocks, at 4 different stations in Academy

Bay, Isla Santa Cruz, by Allyn G. Smith and Jacqueline De Roy. The specimens range in length up to a maximum of 9 mm. They all have the typical pustulose sculpture occurring on all species in the genus. The mucro of the tail valve is median in position, which places this form of *Chaetopleura* in the typical subgenus. The lateral areas of the intermediate valves are prominent and decorated with 3-4, more or less anastomosing, diagonal rows of rounded, projecting pustules. The central areas have less prominent, closely-set, longitudinal pustular rows. The head valve has 15-18 anastomosing rows of pustules; on the tail valve the pustules are fewer and randomly placed. The girdle is covered with exceedingly small, chaffy, scale-like processes and with numerous, short, curved, glassy spicules; there is a well-developed foot-fringe. Color is a nondescript brownish-green with some lighter maculations. One of the specimens, measuring 6.4 mm in length, has a slit formula 8-1-10.

**Remarks:** All 11 specimens of the Galápagos *Chaetopleura* appear to be close to *C. mixta* from the Gulf of California, although smaller in average size. Also, the pustules decorating the lateral areas of the valves, and the central areas as well, tend to be slightly shorter in length, a little greater in diameter, and more regularly spaced than they are on *C. mixta*. Thus, if these differences do not turn out to be a criterion of age, or of individual variation within the species based on a study of a larger series of specimens than those now available, this small Galápagos *Chaetopleura* may be in need of a new name.

One might have expected to find *Chaetopleura lurida* (Sowerby, 1832) or a chiton equivalent to this hairy-girdled species in the Galápagos group. But, although abundant in the Panamic region from the Gulf of California to at least Panamá, so far it has not been reported from these islands.

*Calloplax* Thiele, 1909

*Calloplax duncanus* (Dall, 1919)

(Figures 8, 9)

*Callistochiton duncanus* DALL, 1919: 512-513 - THORPE  
(in KEEN), 1971: 873

This small, yellowish-white chiton was described by Dall from specimens collected on Duncan Island (Isla Pinzón) by members of the USS *Albatross*. The holotype is in the United States National Museum (USNM 218772). Duncan Island must be regarded, therefore, as the type locality. In addition to the holotype, available through the courtesy of Dr. Joseph Rosewater, series of specimens were studied from collecting at Isla Pinzón (CASG 45412), Isla Santa Cruz (ANSP 243647; CASG 40364, 40493, 40497; CASIZ Colln.), Isla Baltra (CASG 42196), Isla Santa Fé (CASG 40365), Isla San Salvador (CASG 42194), Isla Fernandina (CASG 42200), Isla Pinta (CASIZ Colln.).

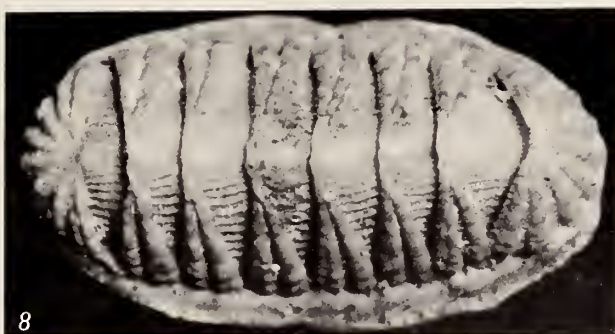
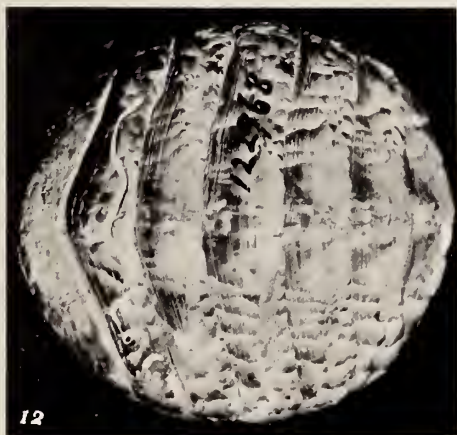
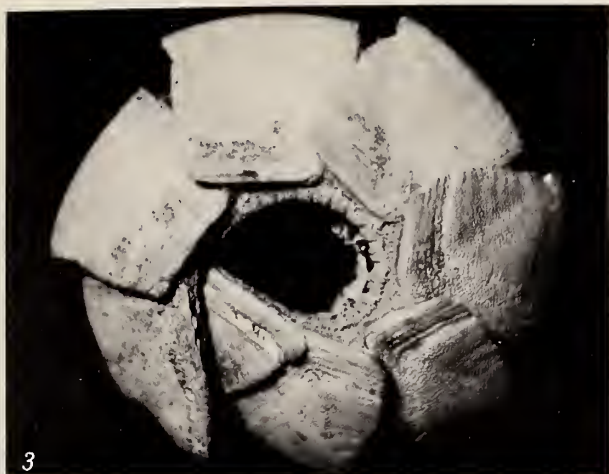
**Remarks:** Maximum adult size of *Calloplax duncanus* ordinarily does not exceed 12-13 mm. In sculptural details there is a fair amount of individual variation. In some specimens the central areas of the intermediate valves have a longitudinal series of threads only; in others, usually younger animals, there is a weaker series of transverse threads dividing the interspaces between the axials into squarish pits. Some also have over-all finely granular micro-sculpture. The normal number of annulate ribs on the head valve is 9, and on the tail valve 6 as indicated by Dall in his original description. However, these ribs tend to bifurcate (as they do also on the lateral areas of the intermediate valves) with the size and hence the age

#### Explanation of Figures 3, 4, 8, 9, 12, 22

Figure 3: *Leptochiton opacus* (Dall, 1908). Holotype (USNM 110664). Dredged in 3667 m off the coast of Perú. Side view of curled specimen. From CASIZ Color slide No. 1581 (AGS photog.).  
Figure 4: *Leptochiton opacus* (Dall, 1908). Paratype. Dorsal view of valves i, iv, v(?), and viii; width of valve i, 9.8 mm. From CASIZ Color Slide No. 1582 (AGS photograph).  
Figure 8: *Calloplax duncanus* (Dall, 1919). Isla Santa Fé. Dorsal view; length, 10.0 mm (CASG 40365). From CASIZ Color Slide No. 1394 (AGS photograph).  
Figure 9: *Calloplax duncanus* (Dall, 1919). Holotype, (USNM 218772). Duncan Island (Isla Pinzón). Dorsal view of valves i, ii,

iii, vii (?), and viii; width of valve i, 3.5 mm. From CASIZ Color Slide No. 1349 (AGS photograph).  
Figure 12: *Placiphorella blainvillii* (Broderip, 1832). Dredged off Cocos Island, Costa Rica, in 66 fathoms (120.7 m) by the USS *Albatross* (USNM 122968). Dorsal view; length, 29 mm; width, 27 mm. From CASIZ Color Slide No. 1579 (AGS photograph).  
Figure 22: *Acanthochitona* spec. ? "Seymour Bay" [= S. Seymour Channel?], Isla Santa Cruz. Dorsal view of disarticulated valves i, ii, iii (?), vii, and viii (ANSP 153484). From CASIZ Color Slide No. 1351 (AGS photograph).









of the animals, resulting in the rib counts at the valve margins as high as 13 or 14 on both end valves in some instances. While the usual color of the dorsal surfaces of the valves is cream-white, a number of specimens have grayish-green mottlings, and in these the girdles have alternating bands of a similar color. Still fewer animals have light red-brown mottlings on the valves.

The "velvety girdle densely covered with minute whitish spicules" mentioned by Dall in his original description is true of all specimens studied, especially those preserved in alcohol. The girdle "scales" are extremely minute and chaffy, the striation on them being visible only under magnification of more than 400 $\times$ . This is not the typical girdle decoration on species in the genus *Callistochiton*, which calls for: "Girdle poreless, densely, clothed with minute striated or smooth scales." (PILSBRY, 1893, 14: 260). In *Callistochiton* species the closely-packed, imbricating scales are "minute" but not so minute as to require high magnification to be visible. In addition, the girdle of *C. duncanus* shows often a fringe of spicules about 100  $\mu$ m long, and occasional similar spicules interspersed amidst the girdle scales. These spicules are apparently very fragile, and will easily fall off in a dry specimen. Thus, in view of the girdle characteristics, *C. duncanus* cannot be assigned properly to the genus *Callistochiton* s.s., and appears more nearly to fit the requirements of the genus *Calloplax* and hence may be viewed as the Panamic regional counterpart of the Caribbean species, *C. janeirensis* (Gray, 1828).

A disarticulated specimen of *Calloplax duncanus* shows important details: the interior is white; the sutural laminae are wide, separated by a rather narrow and weakly denticulated sinus; the teeth are somewhat thickened outside at the slits which correspond in number and position to the external ribs. Slit formula 7-1-9. The eaves are rather wide, roughened, and grooved. These characteristics of the articulamentum are so much in line with those found in members of the genus *Callistochiton* as to suggest that, for their similarities, *Calloplax* and *Callistochiton* may eventually be considered to belong to the same family Callistoplacidae.

#### *Calloplax janeirensis* (Gray, 1828)

*Lepidopleurus janeirensis* (Gray, 1828). WIMMER, 1879: 506  
*Chaetopleura janeirensis*. STEARNS, 1893: 449

This is an Atlantic species, reported by Wimmer from the Galápagos Islands where its occurrence is questionable. We suspect Wimmer's specimens should be referred now to *Calloplax duncanus* (Dall, 1919).

#### CALLISTOPLACIDAE Pilsbry, 1893

#### *Callistochiton* Carpenter in Dall, 1879

#### *Callistochiton carmenae* A.G. Smith & Ferreira, spec. nov.

(Figures 10, 11)

*Callistochiton shuttleworthianus* Pilsbry, 1893. BERGENHAYN, 1937: 284-285, figs. 3f-3g (girdle scales only)

**Diagnosis:** Animal small, yellowish-white. Head valve with 12 low, annulate ribs. Lateral areas of intermediate valves with 2 strong radial ribs; central areas with a pitted appearance. Tail valve with a low mucro, slightly anterior, and 10 annular ribs. Girdle clothed with small, imbricating, oval scales.

**Description of the Holotype:** The holotype is a whole animal, preserved in alcohol, with valves i, ii, and viii disarticulated. Dimensions are 7.8mm in length, and 4.2 mm in width (including girdle). The color is yellowish-white uniformly. The valves are somewhat high-arched, the side slopes gently rounded to a moderately acute jugum. The head valve is semicircular with 12 low, rounded, more or less equally spaced, nodulose, annulate ribs, the posterior ones being strongest and more nodulose. Lateral areas of intermediate valves have 2 strong, radial ribs, the posterior ones heavily nodulose, crenulating the posterior margins of the valves. Sculpture of the central areas consists of about equally and closely spaced diagonal rows of lirae extending from the valve apices and crossed at about right angles by a second series of lirae, forming rounded depressions in the interspaces and giving the central areas a pitted appearance. These lirations become less strong as they cross over the jugal ridges, there being no marked jugal areas. Tail valve has a low rounded mucro positioned slightly anterior to the center of the valve tegmentum, bounded posteriorly by a small semicircular smooth area, and anteriorly by an area sculptured the same as on the central areas of the intermediate valves. The tail valve margin is raised into about 10 short, heavy, somewhat pustulate annular ribs. Internally the valves are white, with a configuration typical for the genus. The slit formula is 12-1-11. The insertion teeth are slightly thickened at the edges, and weakly festooned, corresponding in position to the ribs in the tegmentum. The girdle is clothed with small, diagonally-placed, overlapping, oval scales, which, under magnification of 200 $\times$ , show 13 or 14 slightly granulose, transverse



striae at their tops, while on their sides there is a series of irregularly arranged, rather widely-placed pustules. Girdle width, 0.4 mm.

The holotype was collected at Academy Bay, Isla Santa Cruz (Indefatigable Island), leg. A. G. Smith, 15 February 1964 (GISP Sta. G-59), along with a small series of *Calloplax duncanus*. The holotype is deposited in the CASIZ Type Series no. 696. Two dry paratypes are deposited at CASG Type Series no. 58248. Five additional paratypes from the same locality, collected by Carmen Angermeyer, are preserved in alcohol and deposited in the private collection of Glenn and Laura Burghardt, Oakdale, California.

**Remarks:** Based on the 8 available specimens, animals of this new species vary in length up to 8.7 mm. There is a slight variation in the number of ribs on the head valves, which may range from 10 to 12, and on the tail valves ranging from 8 to 10.

The sculpture on the intermediate and tail valves of *Callistochiton carmenae* differentiates it from other described species in the genus. *Callistochiton carmenae* belongs in the group characterized by having the central areas diagonally ribbed which results in the pitted appearance of the central areas in the intermediate valves; it adds, thus, a fourth species to the group that already includes the West American *C. pulchellus* (Gray, 1828), the Caribbean *C. shuttleworthianus* Pilsbry, 1893, and the Australian *C. antiquus* (Reeve, 1847).

The specimen from Isla Floreana reported by BERGENHAYN (1937) as *Callistochiton shuttleworthianus* Pilsbry, 1893, was located, preserved in alcohol, at the Zoological Museum of Oslo, Norway (No. D 363). The specimen was borrowed for study through the courtesy of Dr. Tor A. Bakke, Curator at the Museum. The specimen was accompanied by a label which read: "Zool. Mus. Oslo nr. D-363 / *Callistochiton shuttleworthianus*, Pilsbr. / Sted: Floreana, i. strandem / 7-9-1925 / Galapagos - Explg. Bergenhayn dt." The specimen is very small (4.5 mm), completely disarticulated. Slit formula 11-1-9. The girdle is preserved entire. On the basis of the conchological

characters observed, there can be no hesitancy in referring Bergenhayns' Isla Floreana specimen to *Callistochiton carmenae*.

*Callistochiton carmenae* honors the malacological contributions of Carmen Angermeyer, of Academy Bay, Isla Santa Cruz, who, with her husband, has added much to the knowledge of the invertebrate fauna of the Galápagos Islands through assiduous shore collecting and dredging using their charter vessel, the M/V *Nixe*.

### *Callistochiton gabbi* Pilsbry, 1893

*Callistochiton gabbi* Pilsbry, 1893. BERGENHAYN, 1937: 282 to 284; figs. 3a-3e (girdle scales only)

No examples of this relatively common Gulf of California *Callistochiton* were collected in the Galápagos Islands in 1964; nor has it been reported since. In all probability, Bergenhayns' record (one 7 mm specimen collected at Isla Floreana) is a misidentification for *Calloplax duncanus*.

### MOPALIDAE Dall, 1889

#### *Placiphorella* Carpenter in Dall, 1879

#### *Placiphorella blainvillii* (Broderip, 1832)

(Figure 12)

*Chiton blainvillii* BRODERIP (in BRODERIP & SOWERBY), 1832: 27

*Placiphorella blainvillii* (Broderip, 1832). DALL, 1909: 246

The type locality is in 17 fathoms (31 m), Inner Lobos Island, Perú, a "few specimens . . . while dredging," collected by Hugh Cuming. The United States National Museum mollusk collection contains no specimen from the Galápagos Islands, although it does have one (USNM

### Explanation of Figures 17 to 21

Figure 17: *Acanthochitona hirudiniformis* (Sowerby, 1832). Academy Bay, Isla Santa Cruz, intertidally. Dorsal view; length, 13.8 mm (CASIZ Collection) (AJF photograph)

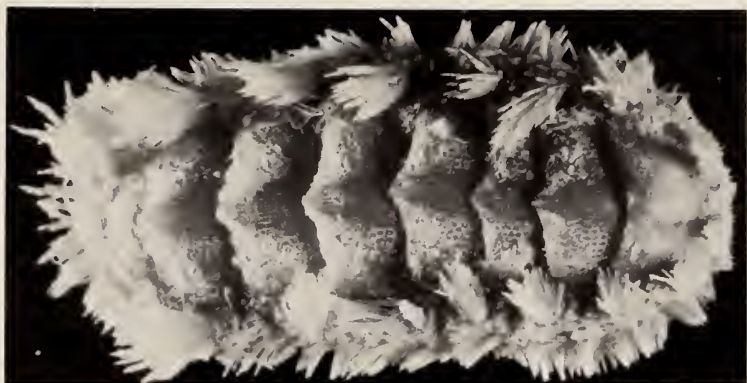
Figure 18: *Acanthochitona jacquelineae* A. G. Smith & Ferreira, spec. nov. Holotype (CASIZ Type Collection No. 967). Dredged in 40-50 m, southern end of Academy Bay, Isla Santa Cruz. Dorsal view; length, 8.3 mm (AJF photograph)

Figure 19: *Acanthochitona jacquelineae* A. G. Smith & Ferreira, spec. nov. Same specimen as Figure 18. Side view (AJF photograph)

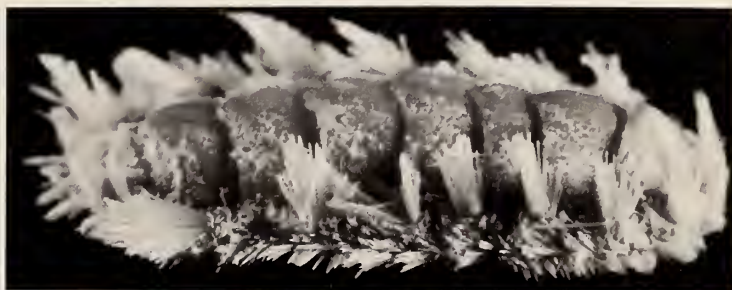
Figure 20: *Acanthochitona* cf. *A. avicula* (Carpenter, 1866). Sullivan Bay, Isla San Salvador. Dorsal view of a cobalt-blue adult; length, 18.2 mm (CASG 42193) (AJF photograph)

Figure 21: *Acanthochitona* cf. *A. avicula* (Carpenter, 1866). Same as Figure 20. Side view (AJF photograph)

18



19



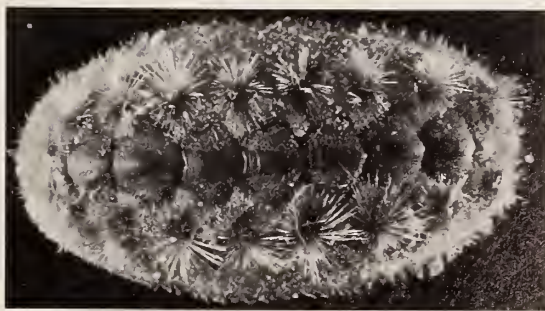
20



21



17







122968) dredged by the USS *Albatross* in 120m, off Cocos Island, Costa Rica (USFC Sta. 3368) (Figure 12). Dall's record for *Placiphorella blainvillii*, from "Galápagos, Cocos and Lobos Islands," appears as the only one published. Since there are no museum lots to substantiate the presence of *P. blainvillii* in the Galápagos group, the record remains in need of confirmation.

#### CHITONIDAE Rafinesque, 1815

##### *Chiton* Linnaeus, 1758

##### *Chiton (Radsia) goodalli* Broderip, 1832

(Figure 13)

- Chiton goodalli* BRODERIP (in BRODERIP & SOWERBY), 1832: 25 - SOWERBY, 1833-1834: 3, 9; plt. 42, fig. 34; plt. 43, fig. 40 - REEVE, 1847: spec. no. 8; plt. 2, fig. 8 - CARPENTER, 1857a: 180 - PAETEL, 1888: 612 - STEARNS, 1893: 404, 449 - PILSBRY & VANATTA, 1902: 552 - DALL, 1909: 247 - SCHWENGEL, 1938: 2 - THORPE (in KEEN), 1971: 864; fig. 4
- Lophyrus goodalli*. CARPENTER, 1857a: 317, 360 - WIMMER, 1879: 505
- Chiton (Lophyrus) goodallii*. E. A. SMITH, 1877: 71
- Chiton (Radsia) chierchiaie* NIERSTRASZ, 1908: 158-163; plt. 3, figs. 15-18, 21-28, 30-31
- Chiton (Radsia) goodallii*. PILSBRY, 1893: 14: 191; plt. 28, figs. 5-8; plt. 29, fig. 9 - BARTSCH & REHDER, 1939: 17 - LELOUP, 1955: 1-10; figs. 2a-2c (girdle scales)

This very large, smooth, blackish species heretofore has been considered as being endemic in the Galápagos Islands although there is a recent record of its occurrence on the South American mainland at Santa Elena, Ecuador (METIVIER, 1969: 587). Among the Recent Polyplacophora its adult length of 11 to 12.5 cm is exceeded only by the Australian *Acanthozostera gemmata* (Blainville, 1825), which has been reported as long as 15 cm, and the giant *Cryptochiton stelleri* (Middendorff, 1847), which ranges up to 30 cm. *Chiton goodalli* was described by Broderip from specimens supplied by the British conchologist Hugh Cuming, who obtained it during one of his voyages around the world in search of rare shells. Broderip recorded it from Isla San Salvador (James Island), which can be accepted as the type locality. Other records are from Isla Isabella (Pilsbry & Vanatta), Isla Floreana (Bartsch & Rehder), and from Isla San Cristóbal (Schwengel). During the California Academy of Sciences 1905-06

Expedition, W. H. Ochsner collected the species at Isla Isabela (CASG 39557), and at Isla Española (CASG 39556).

In 1964, the senior author encountered *Chiton goodalli* fairly commonly in the intertidal zone in the vicinity of Academy Bay on Isla Santa Cruz. The animals were observed to congregate in groups of a few to a dozen or more in narrow cracks in the lava. At no time were they seen on top of the rocks, which seems to be the normal habitat of the large *Chiton stokesii* Broderip, 1832, on Cocos Island, Costa Rica. Local residents in the vicinity of Academy Bay often prize the large foot of *C. goodalli* as a delicacy; for this reason it was not unusual to find adult specimens drying in the open complete with shells and girdle but with the foot removed.

In a series of adults specimens collected near Nelson's on Academy Bay in 1964 by the senior author, the largest specimen preserved in alcohol in a flattened condition (CASIZ Collection) measures 123 mm in length, 78 mm in width, and 22 mm in height.

Although the dorsal surface in specimens of *Chiton goodalli* normally is quite smooth, some shells exhibit a tendency toward faint, subobsolete ribbing on all valves. This is a sculptural feature, however, that obviously is well within the limits of individual variation for the species.

**Fossil Record:** Two medium-sized tail valves and an intermediate valve of *Chiton goodalli* were collected in a Pleistocene deposit on Isla San Salvador by the late Leo G. Hertlein during the California Academy's 1931-1932 G. Allan Hancock Galápagos Expedition. This represents the first fossil record for the species. These valves are deposited in the California Academy of Sciences (CASG 27255).

##### *Chiton (Radsia) sulcatus* Wood, 1815

(Figure 14)

- Chiton sulcatus* WOOD, 1815: 16; plt. 3, fig. 1 - SOWERBY, 1833-1834: 2, 9; plt. 39, fig. 12 - REEVE, 1847, sp. no. 15; plt. 3, fig. 15 - STEARNS, 1893: 404, 408 - PILSBRY & VANATTA, 1902: 552 - DALL, 1909: 247 - SCHWENGEL, 1938: 12 - THORPE (in KEEN), 1971: 864, fig. 6 - METEVIER, 1969: 586
- Lophyrus sulcatus*. CARPENTER, 1857a: 317, 360 - WIMMER, 1879: 506
- Chiton (Lophyrus) sulcatus*. E. A. SMITH, 1877: 71
- Chiton (Radsia) sulcatus*. PILSBRY, 1893: 14: 191-192; plt. 28, figs. 1-4; - STEARNS, 1893: 449 - BOONE, 1933: 202-203; plt. 127 - BARTSCH & REHDER, 1933: 17



This handsome, heavily-sculptured, blue-black chiton has been collected only in the Galápagos Islands. It was described originally by Wood, who said: "This rugged shell is said to inhabit the south seas," a statement now known to be incorrect. It has been reported from Isla Isabela (Bartsch & Rehder; Pilsbry & Vanatta), Isla Floreana (E. A. Smith; Stearns), Isla San Cristóbal (Schwengel), Isla Española (Reeve; Stearns; Wimmer; Boone), Isla Santa Cruz (Stearns), Isla San Salvador (Reeve), Isla Fernandina (Tomlin), and Isla Baltra (Metivier). During the California Academy's 1905-1906 Expedition, W. H. Ochsner collected it on several of these islands, and added Isla Pinzón (CASG).

Isla San Salvador (James Island) may be accepted as the type locality for *Chiton sulcatus* based on Reeve's first localized island record.

In 1964, the senior author found *Chiton sulcatus* in Santa Cruz Island where it was the most abundant species. Generally the shells were clean, without algal or other growths on them. There was some variability noticed in the sculpturing on adult specimens. The largest specimen in the California Academy of Sciences' collection (CASG 39556) was taken on Isla Española by Ochsner; it measures 95 mm in length, 50 mm in width, and 21 mm in height. Most adult specimens are smaller than this.

*Chiton sulcatus* is active; it has a powerful musculature, clinging to any hard substrate with great tenacity. Once removed, it curls up immediately and will not flatten out readily in a bucket of sea water as many other chitons do. Hence good specimens preserved in a flattened condition are the exception rather than the rule.

**Fossil Record:** A single, medium-sized tail valve of *Chiton sulcatus* was collected in a Pleistocene beach deposit during the California Academy's 1931-1932 Expedition by Dr. Hertlein (CASG 27250) and represents the first fossil record of the species. This fossil valve, and the 2 of *C. goodalli* previously mentioned, were not included by Hertlein & Strong in their account of the marine Pleis-

tocene mollusks from the Galápagos Islands published in 1939.

### *Chiton latus* Sowerby, 1825

*Chiton latus* SOWERBY, 1825 [not *Chiton latus* Lowe, 1825] -  
BOONE, 1933: 200; plt. 125, fig. B

Boone reported "one large specimen," collected at Gardner Bay, Hood Island, Galápagos Islands, by the *Ara*, February 4, 1928. Mr. William E. Old of the American Museum of Natural History, New York, has seen the Boone specimen and reports it (*in litt.*) to be *Chiton stokesii* Broderip, 1832, quite probably from Cocos Island, Costa Rica, the erroneous record evidently due to a mixing of labels. This species was not collected on Hood Island (Isla Española) by members of the California Academy's 1905-1906 Expedition and has not been reported otherwise from the Galápagos Islands.

According to PILSBRY (1893, 14: 160-161), *Chiton latus* Sowerby, 1825, is a synonym of *C. magnificus* Deshayes, 1827, which he cites only from Valparaiso, Chile. Thus it is evident that this Chilean species is not a constituent of the Galápagos chiton fauna.

### *Tonicia* Gray, 1847

#### *Tonicia forbesii* Carpenter, 1857

*Tonicia crenulata* (Broderip, 1832) [not *Chiton crenulatus* Risso, 1826]. TOMLIN, 1927: 154  
*Tonicia forbesii* CARPENTER, 1857b: 193

The first Galápagos Island record for this species is by Tomlin who reported it from Isla Floreana under the pre-occupied name of *Tonicia crenulata*. Although the species

### Explanation of Figures 6, 7, 10, 11, 15, 16

Figure 6: *Chaetopleura* cf. *C. mixta* (Dall, 1919). Specimen from Academy Bay, Isla Santa Cruz, low intertidal zone (CASG 40290). Length, 7.3 mm (AJF photograph)

Figure 7: *Chaetopleura* cf. *C. mixta* (Dall, 1919). Close-up of lateral area and girdle (AJF photograph)

Figure 10: *Callistochiton carmenae* A. G. Smith & Ferreira, spec. nov. Paratype (CASG Type Collection No. 58248). Academy Bay, Isla Santa Cruz. Dorsal view; length, 9.2 mm (AJF photograph)

Figure 11: *Callistochiton carmenae* A. G. Smith & Ferreira, spec. nov. Paratype, Burghardt Collection. Academy Bay, Isla Santa Cruz. Close-up of lateral and central areas (AJF photograph)

Figure 15: *Tonicia forbesii arnheimi* Dall, 1903. Adult specimen from Isla Baltra. Dorsal view; length, 23.3 mm (CASG 40356) (AJF photograph)

Figure 16: *Tonicia forbesii arnheimi* Dall, 1903. Same. Close-up of lateral areas to show "eyes" (AJF photograph)

